1990

LAKE & WETLAND MONITORING PROGRAM

REPORT/SUMMARY

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Summary

The Bureau of Environmental Quality Lake and Wetland Monitoring Program surveyed the water quality conditions within 30 Kansas lakes, within seven major river basins, during 1990. Eight were Federal lakes, two were major wetlands, and the remaining 20 represented State Fishing Lakes/State Parks and city/county lakes.

In general, lakes appeared to be constant, over time, with regard to their assigned trophic state. Seventeen lakes indicated reasonably constant trophic states since their last surveys, while six indicated higher trophic state. Three lakes were surveyed in 1990 that indicated an improvement in trophic state.

A total of 122 documented exceedences of Kansas numeric water quality standards occurred in the surface waters of the 30 surveyed lakes. Seventy-two of these exceedences concerned chronic and/or acute aquatic life support standards. Forty-eight concerned water supply, livestock watering, and irrigation uses, and two concerned recreational use. Of the 50 exceedences for human use categories, only 13 occurred in lakes that hosted those particular uses. Therefore, 37 of these exceedences are reported for informational purposes only, and do not represent impairment of current lake uses.

Atrazine was the most often detected pesticide in Kansas lakes. Six lakes had detectable concentrations of atrazine within their main bodies. These detections ranged in concentration from 1.3 to 3.8 μg/L. Dual was detected in four lakes (concentration ranging from 0.30 to 0.69 μg/L), while alachlor was also detected in three (concentration ranging from 0.25 to 0.29 μg/L). All six lakes with detectable atrazine exceed available aquatic life support numeric criteria (EPA Criterion Continuous Concentration of 1.0 μg/L). Two of these six lakes, one of which supports drinking water supply use, exceeded the 3.0 μg/L MCL for atrazine. Dual and alachlor detections did not exceed any of the published numeric criteria.

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INTRODUCTION

Development of the Lake and Wetland Monitoring Program

The Kansas Department of Health and Environment (KDHE) Lake and Wetland Monitoring Program was established in 1975 to fulfill the requirements of the 1972 Clean Water Act (Public Law 92-500) by providing Kansas with background water quality data for water supply and recreational impoundments, by determining regional and time trends for those impoundments, and by identifying pollution control needs within individual lake watersheds.

Program activities originally centered around a small sampling network comprised mostly of Federal lakes, with sample stations at numerous locations within each lake. In 1985, the number of stations per lake were reduced to a single station within the main body of each impoundment. This, and the elimination of parameters with limited interpretive value, allowed expansion of the lake network to its present 125 sites scattered throughout all the major drainage basins and physiographic regions of Kansas.

In 1989, KDHE's Bureau of Environmental Quality (BEQ) initiated a taste and odor technical assistance program for public drinking water supply lakes. This was done to better aid water suppliers in identifying and controlling taste and odor problems related to lake processes and algal ecology.

Overview of the 1990 Monitoring Activities

Staff of the KDHE Lake and Wetland Monitoring Program visited 32 Kansas lakes during 1990, 30 of which were surveyed. Geary County State Fishing Lake (SFL) was too low to allow boat access. A trip to Herington Reservoir was scheduled, but postponed since this lake will be the focus of an intensive assessment project as part of the EPA Clean Lakes Program.

Of the 30 surveyed sites, eight were large Federal lakes last sampled in 1987, five were State Fishing Lakes (SFL's)/State Parks, twelve were city/county lakes (CL's), two were major wetlands/wildlife areas (WMA's) in Kansas, and three were lakes within the Mined Land Recreational Area in southeastern Kansas. Eleven of the 30 lakes serve as public water supplies (PWS's). Four were new to the lake network. Table 1 compiles some general information on the lakes surveyed during 1990.

While man-made lakes are usually termed "reservoirs", this report shall use the term "lake" to define all bodies of standing water within the state.

Table 1. General Information Pertaining to Lakes Surveyed in 1990.

Lake	Basin	Authority	PWS (*)	Last Surveyed
Clark Co. SFL	CI	State	*	1986
Lake Coldwater	CI	Local		1986
Lake Shawnee	KR	Local		1986
Lone Star Lake	KR	Local		1986
Shawnee Mission Lake	KR	Local		1985
Anthony City Lake	LA	Local		1987
Cheney Lake	LA	FMPR	*	1987
Elm Creek Lake	MC	Local		1986
Harveyville Reservoir	MC	Local	*	1985
Hillsdale Lake	MC	FMPR	*	1987, 89
Lake Miola	MC	Local	*	1988
Louisburg SFL	MC	State		1986
Marais des Cygnes WMA	MC	State		new
Melvern Lake	MC	FMPR	*	1987
Miami Co. SFL	MC	State		1986
Pomona Lake	MC	FMPR	*	1987
Rock Creek Lake	MC	Local		1986
Chase Co. SFL	NE	State		1985
Council Grove Lake	NE	FMPR	*	1987
John Redmond Lake	NE	FMPR		1987
Lake Kahola	NE	Local	*	1986
Marion Lake	NE	FMPR	*	1987
Mined Land Lake 5	NE	State		1987
Mined Land Lake 7	NE	State		1987
Mined Land Lake 44	NE	State		1987
Neosho WMA	NE	State		new
Lake Charles	UA	State		new
Concannon SFL	UA	State		new
Augusta SF Lake	WA	Local		1985
El Dorado Lake	WA	FMPR	*	1987

CI = Cimarron
KR = Kansas/Lower Republican
LA = Lower Arkansas
MC = Marais des Cygnes
MO = Missouri
NE = Neosho
SO = Solomon
SS = Smoky Hill/Saline
UA = Upper Arkansas
UR = Upper Republican
VE = Verdigris
WA = Walnut

FMPR = Federal Multipurpose Reservoir
SF = Santa Fe Lake
WMA = Wildlife Management Area (wetland)

In addition to routine lake monitoring, four public water supplies, one recreational lake, and one spring discharge were investigated as part of a taste and odor program within the BEQ at KDHE. The thrust of the program is to determine if lake processes or algal ecology is the primary cause of a given taste and odor incident and to suggest possible corrective measures when applicable.

METHODS

Yearly Selection of Monitored Sites

Since 1985, the 24 large Federal lakes in Kansas have been arbitrarily partitioned into three groups of eight. Each group is sampled once during a three year period of rotation. Up to 22 smaller lakes are sampled each year in addition to that year's block of eight Federal lakes. These smaller lakes are chosen each year for sampling based on three considerations: (1) Is there recent data available (within the last 3-4 years)?; (2) Is the lake showing indications of pollution that require enhanced monitoring?; or (3) Have there been water quality assessment requests from other administrative or regulatory agencies (state, local, or federal)?

Sampling Procedures

At each lake, a boat is anchored over the old stream channel near the dam. This point is station 1 for each lake, and should represent the area of maximum depth. Duplicate samples are taken by Kemmerer sample bottle at 0.5 meters below the surface for inorganic chemistry (basic anions and cations), algal community composition, chlorophyll-a, bacteria (fecal coliform and fecal streptococci), nutrients (ammonia, nitrate, and total phosphorus), and heavy metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc). Duplicate samples are also taken at 0.5 meters above the lake substrate for inorganic chemistry, nutrients, bacteriology, and heavy metals. In addition, a single pesticide sample is taken at 0.5 meters.

Measurements are made in the field for temperature and dissolved oxygen profiles, pH, and Secchi disk depth for each lake at station 1. All samples are preserved and stored in the field as per KDHE Standard Operating Procedure (SOP) requirements (KDHE, 1985). Field measurements, chlorophyll analysis, and algal taxonomy are conducted by staff of the Bureau of Environmental Quality at KDHE. All other analyses are carried out by the KDHE Health and Environmental Laboratory (KDHE, Division of Laboratories, 1984).

Taste and Odor Program

In 1989, the BEQ initiated a formal Taste and Odor Technical Assistance Program. Technical assistance concerning taste and odor incidences in water supply lakes may take on varied form. Investigations may simply involve identification of algal species present within a lake, or they may entail the measurement of numerous physical, chemical, or biological parameters including watershed land use analysis to identify non point pollution sources. Investigations are generally initiated at the request of treatment plant personnel, local authorities, or personnel at any KDHE District Office. While lakes used as public water supplies are the primary focus, a wide variety of samples related to algal odors and fishkills, from both streams and lakes, are accepted for analysis.

RESULTS AND DISCUSSION

Lake Trophic State

Calculation of Carlson Trophic State Indices (TSI's) (Carlson, 1977) remains a useful tool for comparison of lakes in regard to general ecological functioning and level of productivity. Table 2 presents trophic state indices for the 1990 lakes, previous TSI's for those lakes with past data available, and whether or not the lake was dominated by submersed vascular plant communities (macrophytes). Since chlorophyll TSI's are based on the planktonic algal community, a dominance by macrophytes "bumped" the trophic state classification to the next highest level than that assigned by TSI score alone. In all cases, macrophyte dominance meant close to 100% cover of the lake substrate. The system used to assign trophic state, based on the TSI score, is given below. It represents an in-house modification of the Carlson TSI system to account for macrophytic productivity.

TSI score of 0-39 = Oligotrophic/Mesotrophic = O/M or,

> O/M = A lake with a low level of planktonic algae and no large macrophyte community.

TSI score of 40-49 = Mesotrophic = M or,

> M = A lake with only a moderate planktonic algal community, or a small algal community combined with a large macrophyte community.

TSI score of 50-63 = Eutrophic = E or,

E = A lake with a large planktonic algal community or a moderate algal community combined with a large macrophyte community. This category is further divided as follows:

TSI = 50-54 = slightly eutrophic
TSI = 55-59 = eutrophic
TSI = 60-63 = very eutrophic.

TSI score of 64 or greater = Hypereutrophic = H or,

H = A lake with a very large planktonic algal community or a large algal community combined with a large macrophyte community.

All Carlson chlorophyll TSI's are calculated by the following formula, where C is the phaeophytin corrected chlorophyll-a level in μg/L (Carlson, 1977):

$$TSI = 10(6-(2.04-0.68\ln(C))/\ln 2).$$

The composition of the algal community often gives a better ecological picture of a lake than relying solely on a trophic state classification. Table 3 presents both total algal cell count and percent composition in several major algal groups for the 1990 lakes. Lakes in Kansas that are nutrient enriched may tend to be dominated by green or blue-green species, while those dominated by diatom communities may not be so enriched. Certain species of blue-green, diatom, or dinoflagellate algae may contribute to taste and odor problems, when present in large numbers, in lakes or streams that serve as public drinking water supply sources.

Trends in Trophic State

Surveyed lakes in 1990 are presented in four major categories in Table 4: all lakes, large Federal lakes, water supply lakes, and wetlands. Overall, many of the lakes surveyed were very productive; two-thirds of these were eutrophic and about 20% were classed as hypereutrophic. For the larger Federal lakes, less than half were eutrophic and slightly more than half were characterized as mesotrophic. However, large lakes in Kansas would not be expected to have the very high trophic state, common to so many smaller lakes, due to light limitation and/or higher flow-through rate (Wetzel, 1983).

Table 2. Current, and past, TSI's and trophic state classifications for the 1990 lakes. The abbreviations used previously for trophic state levels (O/M, M, E, H) apply here. An asterisk appearing after the name of a lake denotes that the lake was macrophyte dominated. In such a case, the trophic state based solely on TSI score will be in parentheses, followed by the macrophyte adjusted classification.

Lake	1990 TSI & Status		Previous Status
Clark Co. SFL	43	M	M
Lake Coldwater	56	E	H
Lake Shawnee	55	E	E
Lone Star Lake	55	E	E
Shawnee Mission Lake	52	E	M
Anthony City Lake	72	H	H
Cheney Lake	43	M	E
Elm Creek Lake	71	H	M
Harveyville Reservoir	54	E	E
Hillsdale Lk. (overall)	52	E	E
Main Body	43	M	-
Big Bull Arm	60	E	-
Little Bull Arm	54	E	-
Lake Miola	52	E	E
Louisburg SFL	54	E	M
Marais des Cygnes WMA*	59	(E)H	-
Melvern Lake	44	M	M
Miami Co. SFL	81	H	E
Pomona Lake	25	O/M	M
Rock Creek Lake	61	E	E
Chase Co. SFL	49	M	M
Council Grove Lake	53	E	E
John Redmond Lake	49	M	E
Lake Kahola	52	E	M
Marion Lake	60	E	E
Mined Land Lake 5	54	E	E
Mined Land Lake 7	40	M	M
Mined Land Lake 44	46	M	M
Neosho WMA	65	H	-
Lake Charles	63	E	-
Concannon SFL	55	E	-
Augusta SF Lake	64	H	E
El Dorado Lake	41	M	M

Within the category of public water supply (PWS) lakes, most were either mesotrophic or eutrophic. The one O/M lake was Pomona Lake, whose condition was primarily due to large runoff influxes. Wetlands surveyed in 1990 included Neosho WMA in Neosho County, and Marais des Cygnes WMA in Linn County. Both are managed by the Kansas Department of Wildlife and Parks (W&P). Both wetlands were classed as hypereutrophic, which is as expected for such ecosystems (Wetzel, 1983).

Table 5 represents the average trophic state of the lakes sampled within each major river drainage basin in Kansas. Several of the basins in western and southern Kansas are represented by only two lakes during 1990 due to the smaller number of lakes available in those basins. Table 6 presents changes within each basin over time for the 26 lakes with previously calculated TSI's. In general, the basins appear rather constant with regard to lake trophic state.

Surface Water Exceedences of State Water Quality Standards

All numeric water quality standards are taken from Chapter 28 of the Kansas Administrative Regulations (K.A.R. 28-16-28b through K.A.R. 28-16-28f), effective May 1, 1987. Copies of the Standards may be obtained from the Bureau of Environmental Quality, KDHE, Building 740, Forbes Field, Topeka, Kansas 66620.

There were a total of 122 exceedences of various water quality numeric standards and criteria in the surface water of the 30 lakes sampled in 1990. There were a total of 45 chronic aquatic life support exceedences documented for mercury (Hg, 5 total), aluminum (Al, 15 total), lead (Pb, 13 total), iron (Fe, 6 total), copper (Cu, 4 total), and cadmium and zinc (Cd & Zn, 1 each). Acute aquatic life support exceedences numbered 27 total. These 27 included silver (Ag, 2 total), zinc (Zn, 3 total), aluminum (Al, 8 total), copper (Cu, 11 total), lead (Pb, 1 total), and pH (2 total). Table 7 lists the documented surface (zero to 0.5 meters depth) exceedences of aquatic life support standards in 1990.

Under the aquatic life support use category, no clear geographic trends appear to exist for the various metals. However, exceedences appear more common in areas with higher average annual precipitation, suggesting non point sources. In lakes with water supply use, copper exceedences are often due to treatment with copper sulphate. The two exceedences of pH are from lakes with very large phytoplankton communities. The process of photosynthesis, operating within such robust plant communities, can cause pH to rise and fall by as much as two to three units over a 24 hour period in small lakes and wetland pools (Wetzel, 1983).

Table 3. Algal communities present in the 1990 lakes at the time of sampling. The value in the count column is in cells/μL. "Other", in the far right column, refers to euglenoids, cryptophytes, and other single celled flagellates.

Lake	Total Count (cells/μL)	Percent Composition green	blue-green	diatoms	other
Clark Co. SFL	1.6	85	0	7	8
Lake Coldwater	49.1	5	91	<2	<3
Lake Shawnee	16.8	14	58	24	4
Lone Star Lake	4.2	88	<1	3	<9
Shawnee Mission L.	6.0	69	16	5	10
Anthony City Lake	85.4	42	50	2	6
Cheney Lake	4.8	30	53	4	13
Elm Creek Lake	191.3	<1	99	<1	<1
Harveyville Res.	9.1	58	<1	30	12
Hillsdale L. Sta.1	2.0	22	0	64	14
Sta. 2	10.9	41	0	52	7
Sta. 3	3.0	33	0	59	8
Lake Miola	105.5	<1	99	<1	<1
Louisburg SFL	69.9	<2	98	<1	0
Mar. d. Cyg. WMA	73.9	6	88	5	1
Melvern Lake	2.6	5	0	93	2
Miami Co. SFL	524.2	<1	99	<1	0
Pomona Lake	0.4	43	0	57	0
Rock Creek Lake	33.5	19	9	70	2
Chase Co. SFL	2.9	43	17	39	1
Council Grove L.	4.1	23	0	72	5
John Redmond Lake	1.0	44	0	44	12
Lake Kahola	6.2	39	34	22	5
Marion Lake	41.6	6	68	26	<1
Mined Land Lake 5	6.7	28	33	0	39
Mined Land Lake 7	9.7	9	91	<1	0
Mined Land Lake 44	7.2	6	87	4	3
Neosho WMA	4.1	23	0	37	40
Lake Charles	63.0	33	66	<1	0
Concannon SFL	15.8	52	26	22	0
Augusta SF Lake	8.9	54	0	44	2
El Dorado Lake	3.7	48	14	3	34

Table 4. Lake trophic state trends by general lake type.

Category	Number of Lakes		Category	Number of Lakes	
1990 Overall	O/M	1	Public Water Supply Lakes	O/M	1
	M	8		M	4
	E	15		E	6
	H	6		H	0
Federal Lakes	O/M	1	Wetlands	O/M	0
	M	4		M	0
	E	3		E	0
	H	0		H	2

Table 5. Mean trophic state for the 1990 lakes in each major river basin in Kansas. M = mesotrophic, E = eutrophic, and VE = very eutrophic, under mean trophic state.

Basin (No. of Lakes)	Mean TSI	Mean Trophic State
Cimarron (2)	49.5	M-E
Kansas/Lower Republican (3)	54.0	E
Lower Arkansas (2)	57.5	E-VE
Marais des Cygnes (10)	55.3	E
Neosho (9)	52.1	E
Upper Arkansas (2)	59.0	VE
Walnut (2)	52.5	E

Table 6. Trends over time for lake trophic state classification within each major river basin in Kansas. This table deals only with those 26 lakes that have past data.

Basin	Constant	Number of Lakes Improving	Degrading
Cimarron	1	1	-
Kansas/Lower Republican	2	-	1
Lower Arkansas	1	1	-
Marais des Cygnes	6	-	3
Neosho	6	1	1
Upper Arkansas	-	-	-
Walnut	1	-	1

Of the 50 remaining exceedences of water quality numeric standards that involved human use categories, only 13 occurred in lakes that were actually hosting contact recreation, water supply, livestock watering, and irrigation. Table 8 indicates the documented exceedences of human use categories that occurred in lake surface waters during 1990. Exceedences in Table 8 that did not coincide with an existing use at a lake are indicated by marking the parameter with parentheses.

No trends were noted in human use category exceedences. The higher bacterial counts, that were counted as an exceedence for contact recreation, at Melvern Lake are due to large influxes of runoff during early June. These runoff events caused flooding throughout the east-central region of Kansas, and very high water levels at all three federal lakes in Osage and Coffey Counties (Melvern, Pomona, and John Redmond Lakes). At Melvern, sampling occurred close enough to the event that natural bacterial die off had not yet taken place, as it normally does in a lake system.

Pesticides in Kansas Lakes, 1990

Seven lakes had detectable pesticides within the main body of the lake during 1990. Table 9 lists these lakes and what pesticides were detected, along with the level detected and analytical quantification limit. Three pesticides were detected in total.

As in the past, atrazine is the most often detected pesticide in lakes in Kansas (KDHE, 1989). Six of the seven lakes with measurable levels of pesticides had atrazine present in detectable quantity (Table 9). Dual (metolachlor) and alachlor were detected

Table 7. Chemical parameters exceeding chronic and acute aquatic life support standards in the surface waters of the 1990 lakes. Chemical symbols are from the Periodic Table of the Elements, except for pH. Aquatic life support is abbreviated as ALS.

	Chronic ALS							Acute ALS					
Lake	Hg	Cd	Al	Pb	Cu	Fe	Zn	Ag	Zn	Pb	Cu	pH	Al
Clark Co. SFL													
Lake Coldwater			x	x	x								
Lake Shawnee	x		x	x							x		
Lone Star Lake				x					x		x		
Shawnee Mission Lake			x	x				x			x		
Anthony City Lake	x	x		x		x						x	x
Cheney Lake				x									x
Elm Creek Lake			x	x	x								
Harveyville Res.			x	x							x		
Hillsdale Lake			x						x	x	x		
Lake Miola			x								x		
Louisburg SFL					x								
Marais des Cygnes WMA			x	x							x		
Melvern Lake			x		x								
Miami Co. SFL			x					x			x	x	
Pomona Lake						x							x
Rock Creek Lake			x	x							x		
Chase Co. SFL			x										
Council Grove Lake	x			x		x	x						x
John Redmond Lake				x		x			x				x
Lake Kahola	x												
Marion Lake			x										
Mined Land Lake 5													
Mined Land Lake 7													
Mined Land Lake 44													
Neosho WMA				x		x					x		x
Lake Charles	x					x							x
Concannon SFL													x
Augusta SF Lake			x										
El Dorado Lake			x								x		

Table 8. Exceedences of human use standards within the surface waters of the 1990 lakes. Symbols are taken from the Periodic Table of the Elements, with the exception of TDS which stands for Total Dissolved Solids, TH which stands for Total Hardness, SUL which stands for sulphate, and FC which stands for Fecal Coliform Bacterial Counts. Use category abbreviations are as follows: IR = irrigation, LW = livestock watering, WS = water supply, and CR = contact recreation. Parentheses mean that while a certain parameter exceeded the water quality criterion for that use, the use was not hosted at that particular lake.

Lake	IR Use		LW Use	WS Use					CR Use
	Mn	F	SUL	Fe	Mn	SUL	TH	TDS	FC
Lone Star Lake					x				
Anthony City Lake	()			()	()			()	
Cheney Lake				x					
Elm Creek Lake					()				
Harveyville Res.				x	x				
Hillsdale Lake				x					
Marais des Cygnes WMA	()			()	()				
Melvern Lake				x					x
Miami Co. SFL	()			()	()				
Pomona Lake				x					
Rock Creek Lake				()	()				
Chase Co. SFL					()				
Council Grove Lake				x					
John Redmond Lake				()	()				
Lake Kahola				x	x				
Marion Lake				x				x	
Mined Land Lake 5					()				
Mined Land Lake 7			()		()	()	()	()	
Mined Land Lake 44			()			()	()	()	
Neosho WMA				()	()				
Lake Charles		()		()	()				()
Concannon SFL		()		()	()				
Augusta SF Lake				()	()				

in 4 and 3 lakes, respectively. In all cases, the detection of these pesticides indicate agricultural non point pollution. The lake of most concern, with regard to pesticides, is Hillsdale Lake. Hillsdale Lake not only had the second highest level of detected atrazine (above the Maximum Contaminant Level of 3.0 μg/L proposed by EPA) in 1990, but also serves as a public drinking water supply. While the atrazine level in Lone Star Lake also exceeds 3.0 μg/L, it is not currently used for water supply.

Discussion of Non Point Pollution Sources for Selected Lakes

Thirteen lakes were selected, out of the 30, for individual discussion of non point pollution sources. It was felt that these lakes merited individual attention based on the number and type of observed Water Quality Standard exceedences. From Table 7, a lake was selected if more than three parameters exceeded an aquatic life support standard, or more than one acute aquatic life support standard was exceeded. From Table 8, a lake was selected if more than one parameter exceeded a human use category, or if more than one use category had an exceedence. For the purposes of this discussion, only human use exceedences in lakes that hosted those particular uses were counted.

The thirteen lakes chosen for further discussion are the following:

> Marion, Melvern, Council Grove, Hillsdale, and John Redmond federal lakes, and smaller lakes including Lake Shawnee, Shawnee Mission Lake, Lone Star Lake, Lake Kahola, Harveyville Reservoir, Neosho WMA, Anthony City Lake, and Miami Co. SFL.

All thirteen appear to be affected by agricultural and/or urban non point source pollution. Most metals exceeding state water quality standards are those which are crustal in origin, and not generally associated with human industrial activities, etc. However, copper is often detected as a result of algae control efforts in water supply lakes. As mentioned before, the pH exceedences at Miami Co. SFL and Anthony City Lake are due to the large algal communities present in both lakes at the time of the survey. The only exceedences of cadmium and mercury, which usually are related to urban/industrial activity, occurred at Lake Shawnee and Anthony City Lake. In both cases, the occurrence of the metals may be partially due to urban runoff. The single occurrence of lead levels in excess of the acute aquatic life support criterion, was at Hillsdale Lake. As a portion of the City of Gardner, and several wastewater treatment plant discharges are in the watershed, this lead detection may not be attributable solely to crustal sources.

Table 9. Pesticides detected during 1990 in Kansas lakes. All values are in $\mu g/L$. Analytical quantification limits are as follows for the three detected pesticides: atrazine = 1.2, dual = 0.25, alachlor = 0.25. The "exceeded" column refers to whether the detection of atrazine exceeded current EPA aquatic life support (ALS) levels (1.0 $\mu g/L$), or whether the detection exceeded the current MCL of 3.0 $\mu g/L$ for water supply (WS).

Lake	Pesticide			Exceeded	
	Atrazine	Dual	Alachlor	ALS	WS
Lone Star	3.8	0.69		x	x
Hillsdale	3.1		0.29	x	x
Lake Miola	1.3	0.30		x	
Louisburg SFL			0.26		
Marais des Cygnes WMA	1.5			x	
Pomona	2.5	0.41		x	
John Redmond	2.6	0.35	0.25	x	

Taste and Odor Investigations in 1990

During October 1, 1989 to October 1, 1990, there were six taste and odor investigations conducted by the Bureau of Environmental Quality's Taste and Odor Program. Three were on river systems, two were on lakes, and one was a spring discharge. In addition, algae samples were investigated for two major fishkills in Kansas during the summer of 1990.

On October 9, 1989, southeast district office staff brought in samples from two separate taste and odor complaints on the Neosho River. At both Neodesha and Fredonia, raw water had a "tea" color and both raw and treated water had an odor of mustiness. Microscopic examination of the water indicated that there was a large population of blue-green algae (Anabaena sp.) present. Cell count was estimated at 14,000-18,000 cells/mL at Fredonia and at 17,000-26,000 cells/mL at Neodesha. At these levels, blue-green algae are quite capable of causing taste and odor problems (Palmer, 1959; Haynes, 1988).

On January 31, 1990, samples from the Marmaton River at Fort Scott were brought in with raw water displaying a greenish-brown color and musty odor. Treated water, while clear, had an odor described as septic. Microscopic examination revealed a large population of the colonial golden algae, Synura uvella. This algae has caused taste and odor problems throughout the world according to the literature (Palmer, 1959; Nicholls, 1985). Within North America the problems have been in colder water regions like New England and Canada. Use of activated carbon was found to be successful in removing the odor from water taken from the Marmaton River.

On September 10, 1990, an algae sample was brought in by staff from KDHE's Bureau of Environmental Remediation from Mingenback Lake in McPherson, Kansas. The lake had been reported as having been contaminated by an oily substance, and KDHE staff began the investigation as a possible chemical spill. Microscopic examination of the sample showed that there was a large population of the blue-green algae Microcystis aeruginosa. This algae produces waste products that smell very much like petroleum products, similar to the aroma near an active oil well. The algae is also very common in small, nutrient rich ponds, once the summer water temperatures have risen to an average of 25-30^{o} Celsius.

On September 11, 1990, South Central District Office staff brought algae samples from Cheney Lake due to a severe taste and odor problem in Wichita. Wichita is dependant on Cheney Lake for part of its water supply. The remainder of the City water supply comes from well fields. Examination of the lake water revealed a very large blue-green community, composed of several species. The total cell count was between 240,000 and 330,000 cells/mL, with 85% of the community composed of Microcystis aeruginosa. This blue-green algae is a common producer of taste and odor problems, as well as toxic blooms that are linked to both fishkills and livestock poisonings (Carmichael, 1985).

On September 19, 1990, a spring discharge sample was brought in by South Central District Office (SEDO) staff. The sample was from Timber Creek above the city of Winfield. The sample had no identifiable algae present. The only materials present were chunks of bright yellow debris with very small colorless filaments woven through the larger pieces of yellow material. The yellow material was readily identified as elemental sulphur, due to the color and distinctive odor. The filaments were tentatively identified as either filamentous bacteria or aquatic fungal hyphae. It was also indicated that water chemistry taken from the site was higher in sulphate and chloride than most groundwater in the vicinity of the spring. SEDO staff were asked to investigate the surrounding area for evidence of a potential source of oil field or brine pollution.

During August, 1990, major fishkills occurred in two Federal lakes, Marion and Melvern. At Marion Lake, algae samples revealed a large blue-green algal community, along with an equally large zooplankton and protist community. However, these organisms did not appear to be the primary cause of the fish kill. Most of the fish that died were larger, older fish, all of which seemed to be affected with various types of secondary infection. It was surmised, after joint investigation with the Kansas Department of Wildlife and Parks (KDWP), that some form of previous stress, possibly thermal, had weakened these larger fish and allowed the intense level of secondary infection to develope (KDWP, personal communication).

At Melvern Lake, during late July and early August, 1990, a large fishkill composed almost exclusively of channel catfish occurred. KDWP estimated that about 30,000 fish total were killed during the incident, with about 27,000 of those being channel catfish. The cause was tentatively identified as a dinoflagellate algae, Gymnodinium acidotum. This same algae was apparently involved in a past fishkill incident at Stockton Reservoir in Missouri (Fields & Rhodes, 1991). While the algae continued to be found sporadically in Melvern Lake throughout August, no further fishkill was noted. A detailed report concerning the investigation of the Melvern Lake fishkill is currently in preparation by BEQ staff.

Conclusions

The following conclusions are offered, based upon the lake monitoring data obtained during 1990.

1. Most lakes appeared constant, regarding trophic state assignment, over time.

2. Thirteen lakes had sufficient numbers of surface water quality standards exceedences to be discussed in more detail within the report. Of these thirteen, all were viewed as being affected by non point urban, agricultural, and natural metal loading. No geographic trends in metal loading were noticed. Some of the larger federal lakes were also affected by large runoff inflows during June.

3. Seven of the 30 surveyed lakes had detectable quantities of agricultural pesticides during the summer of 1990. Atrazine was the most commonly encountered pesticide. The majority of the seven lakes were located within the Marais des Cygnes River Basin, which supports abundant agricultural activity and has higher levels of average annual runoff than most parts of Kansas.

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LAKE DATA AVAILABILITY

Lake data is available for all lakes within the Lake and Wetland Monitoring Program in Kansas. Water quality data may be requested by writing to the Bureau of Environmental Quality, KDHE, Building 740, Forbes Field, Topeka, Kansas 66620. All data referenced within this report is accessible on STORET.